

CLAIMS:

- 1
- 2 1. A fuel cell power system comprising:
- 3 a plurality of fuel cells electrically coupled with plural terminals
- 4 and individually configured to convert chemical energy into electricity;
- 5 and
- 6 a digital control system configured to at least one of control and
- 7 monitor an operation of the fuel cells.
- 8
- 9 2. The fuel cell power system according to claim 1 wherein the
- 10 control system is configured to control the operation.
- 11
- 12 3. The fuel cell power system according to claim 1 wherein the
- 13 control system is configured to monitor the operation.
- 14
- 15 4. The fuel cell power system according to claim 1 wherein the
- 16 fuel cells are coupled in series.
- 17
- 18 5. The fuel cell power system according to claim 1 wherein the
- 19 control system comprises a plurality of distributed controllers.
- 20
- 21 6. The fuel cell power system according to claim 5 wherein the
- 22 distributed controllers are configured in a master\slave relationship.
- 23
- 24

1 7. The fuel cell power system according to claim 1 wherein the
2 fuel cells comprise polymer electrolyte membrane fuel cells.

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4 8. The fuel cell power system according to claim 1 wherein the
5 fuel cells are configured to be individually selectively deactivated and
6 remaining ones of the fuel cells are configured to provide electricity to
7 the terminals with others of the fuel cells deactivated.

8
9 9. The fuel cell power system according to claim 8 wherein the
10 fuel cells are individually configured to be physically removable.

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12 10. The fuel cell power system according to claim 8 wherein the
13 fuel cells are individually configured to be electrically bypassed.

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15 11. The fuel cell power system according to claim 1 further
16 comprising a plurality of switching devices configured to selectively shunt
17 respective fuel cells.

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19 12. The fuel cell power system according to claim 11 wherein
20 the control system is configured to monitor at least one electrical
21 characteristic of the fuel cells and to control the switching devices
22 responsive to the monitoring.
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13. The fuel cell power system according to claim 1 further comprising:

a housing about the fuel cells;
a temperature sensor within the housing; and
an air temperature control assembly configured to at least one of increase and decrease the temperature in the housing.

113
14. The fuel cell power system according to claim 13¹² wherein the control system is configured to monitor temperature using the temperature sensor and to control the air temperature control assembly responsive to the monitoring to maintain the temperature within the housing within a predefined range.

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15. The fuel cell power system according to claim 13¹² wherein the control system is configured to monitor temperature using the temperature sensor and to control the air temperature control assembly responsive to the monitoring to maintain the temperature within the housing within a predefined range of approximately 25 °Celsius to 80 °Celsius.

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16. The fuel cell power system according to claim 1 further comprising a fan configured to direct air to the fuel cells, and the control system is configured to control the fan.

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17. The fuel cell power system according to claim 1 further comprising a plurality of valves configured to supply fuel to respective fuel cells, and the control system is configured to control the valves.

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18. The fuel cell power system according to claim 1 further comprising a main valve configured to supply fuel to the fuel cells, and the control system is configured to control the main valve.

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19. The fuel cell power system according to claim 1 further comprising a communication port adapted to couple with a remote device, and the control system is configured to communicate with the remote device via the communication port.

19
20. The fuel cell power system according to claim 19 wherein the shut down operation deactivates one or more of the fuel cells.

20
21. The fuel cell power system according to claim 19 wherein the shut down operation deactivates all the fuel cells.

21
22. The fuel cell power system according to claim 1 further comprising a switching device intermediate one of the terminals and the fuel cells, and the control system is configured to control the switching device.

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1 23. The fuel cell power system according to claim 1 further
2 comprising:

3 a housing about the fuel cells; and

4 a fuel sensor configured to monitor for the presence of fuel
5 within the housing, and the control system is coupled with the fuel
6 sensor and configured to implement a shut down operation responsive
7 to a detection of fuel within the housing.

8
9 123 24. The fuel cell power system according to claim 1 wherein the
10 fuel cells are provided in a plurality of cartridges.

11
12 124 25. A fuel cell power system comprising:

13 a housing;

14 a plurality of terminals;

15 a plurality of fuel cells within the housing and electrically coupled
16 with the terminals and configured to convert chemical energy into
17 electricity;

18 a plurality of valves adapted to couple with a fuel source and
19 configured to selectively supply fuel to respective fuel cells; and

20 a control system configured to control the plurality of valves.

21
22 125 26. The fuel cell power system according to claim 25 124 wherein
23 the control system comprises a plurality of distributed controllers.
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27. The fuel cell power system according to claim 25 wherein the fuel cells comprise polymer electrolyte membrane fuel cells.

28. The fuel cell power system according to claim 25 wherein the fuel cells are configured to be individually selectively deactivated and remaining ones of the fuel cells are configured to provide electricity to the terminals with others of the fuel cells deactivated.

29. The fuel cell power system according to claim 28 wherein the fuel cells are individually configured to be physically removable.

30. The fuel cell power system according to claim 28 wherein the fuel cells are individually configured to be electrically bypassed.

31. The fuel cell power system according to claim 25 wherein the control system is configured to monitor at least one electrical characteristic of the fuel cells and to control the respective valves responsive to the monitoring.

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32. A fuel cell power system comprising:

a housing;

a plurality of terminals;

at least one fuel cell within the housing and electrically coupled with the terminals and configured to convert chemical energy into electricity;

a bleed valve configured to selectively purge matter from the at least one fuel cell; and

a control system configured to control selective positioning of the bleed valve.

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33. The fuel cell power system according to claim 32 wherein the control system comprises a plurality of distributed controllers.

34. ~~The fuel cell power system according to claim 32 wherein the at least one fuel cell comprises a plurality of polymer electrolyte membrane fuel cells.~~

35. ~~The fuel cell power system according to claim 32 wherein the at least one fuel cell comprises a plurality of fuel cells.~~

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1 36. The fuel cell power system according to claim 35 wherein
2 the fuel cells are configured to be individually selectively deactivated
3 and remaining ones of the fuel cells are configured to provide electricity
4 to the terminals with others of the fuel cells deactivated.

5
6 37. The fuel cell power system according to claim 32 wherein
7 the control system is configured to periodically open the bleed valve.

8
9 38. The fuel cell power system according to claim 32 further
10 comprising a connection arranged to provide drainage from an anode
11 side of the at least one fuel cell to the bleed valve.

12
13 39. A fuel cell power system comprising:
14 a housing;
15 a plurality of terminals;
16 at least one fuel cell within the housing and electrically coupled
17 with the terminals and configured to convert chemical energy into
18 electricity;
19 a fan within the housing and configured to direct air to the at
20 least one fuel cell; and
21 a control system configured to control an operation of the fan.

22
23 40. The fuel cell power system according to claim 39 wherein
24 the control system comprises a plurality of distributed controllers.

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41. The fuel cell power system according to claim 39 wherein
the at least one fuel cell comprises a plurality of polymer electrolyte
membrane fuel cells.

42. The fuel cell power system according to claim 39 wherein
the at least one fuel cell comprises a plurality of fuel cells.

43. The fuel cell power system according to claim 42 wherein
the fuel cells are configured to be individually selectively deactivated
and remaining ones of the fuel cells are configured to provide electricity
to the terminals with others of the fuel cells deactivated.

44. The fuel cell power system according to claim 39 further
comprising at least one sensor configured to at least one of monitor
current supplied to a load coupled with the terminals and monitor
voltage of the at least one fuel cell, and the control system is
configured to control a rate of air flow of the fan responsive to the
monitoring.

45. The fuel cell power system according to claim 39 wherein
the at least one fuel cell includes a cathode side and the fan and the
housing are configured to direct air into the cathode side of the at
least one fuel cell.

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1 46. The fuel cell power system according to claim 39 further
2 comprising a plenum within the housing and configured to direct air
3 from the fan to the at least one fuel cell.

4
5 47. The fuel cell power system according to claim 46 wherein
6 the plenum is configured to direct air to a cathode side of the at least
7 one fuel cell.

8
9 48. The fuel cell power system according to claim 39 further
10 comprising an air flow device configured to operate responsive to
11 control from the control system to permit selective passage of air at
12 least one of into and out of the housing.

13
14 49. The fuel cell power system according to claim 39 further
15 comprising monitoring circuitry configured to monitor an air flow rate
16 of the fan and output a signal indicative of the air flow rate to the
17 control system.

18
19 50. The fuel cell power system according to claim 49 wherein
20 the control system is configured to control an air flow rate of the fan.
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51. A fuel cell power system comprising:

a housing;

a plurality of terminals;

at least one fuel cell within the housing and electrically coupled with the terminals and configured to convert chemical energy into electricity;

a control system configured to at least one of control and monitor an operation of the at least one fuel cell; and

an operator interface coupled with the control system to indicate at least one operational status responsive to control from the control system.

52. The fuel cell power system according to claim 51 wherein the control system comprises a plurality of distributed controllers.

53. The fuel cell power system according to claim 51 wherein the at least one fuel cell comprises a plurality of polymer electrolyte membrane fuel cells.

54. The fuel cell power system according to claim 51 wherein the at least one fuel cell comprises a plurality of fuel cells.

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1 55. The fuel cell power system according to claim 54 wherein
2 the fuel cells are configured to be individually selectively deactivated
3 and remaining ones of the fuel cells are configured to provide electricity
4 to the terminals with others of the fuel cells deactivated.

5 49
6 56. The fuel cell power system according to claim 51 46 wherein
7 the operator interface is positioned for observation from the exterior of
8 the housing.

9 50
10 57. The fuel cell power system according to claim 51 46 wherein
11 the operator interface comprises a display configured to emit a human
12 perceptible signal.

13 51
14 58. The fuel cell power system according to claim 51 46 wherein
15 the operator interface comprises interface switches configured to receive
16 operator inputs.

17
18 59. A fuel cell power system comprising:
19 a plurality of terminals;
20 at least one fuel cell electrically coupled with the terminals and
21 configured to convert chemical energy into electricity;
22 a power supply configured to selectively supply electricity; and
23 a control system configured to monitor at least one operational
24 condition of the power supply.

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1 60. The fuel cell power system according to claim 59 wherein
2 the control system comprises a plurality of distributed controllers.

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4 61. The fuel cell power system according to claim 59 wherein
5 the at least one fuel cell comprises a plurality of polymer electrolyte
6 membrane fuel cells.

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8 62. The fuel cell power system according to claim 59 wherein
9 the at least one fuel cell comprises a plurality of fuel cells.

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11 63. The fuel cell power system according to claim 62 wherein
12 the fuel cells are configured to be individually selectively deactivated
13 and remaining ones of the fuel cells are configured to provide electricity
14 to the terminals with others of the fuel cells deactivated.

15
16 64. The fuel cell power system according to claim 59 wherein
17 the power supply supplies electricity to the control system.

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19 65. The fuel cell power system according to claim 59 wherein
20 the power supply includes a battery.

21
22 66. The fuel cell power system according to claim 65 further
23 comprising charge circuitry configured to selectively charge the battery
24 responsive to control from the control system.

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67. The fuel cell power system according to claim 59 further comprising an operator interface and the control system is configured to control the operator interface to indicate the at least one operational condition.

68. A fuel cell power system comprising:
a plurality of terminals;
at least one fuel cell electrically coupled with the terminals and configured to convert chemical energy into electricity;
a sensor configured to monitor at least one electrical condition of the at least one fuel cell; and
a control system coupled with the sensor and configured to monitor the sensor.

69. The fuel cell power system according to claim 68 wherein the control system comprises a plurality of distributed controllers.

70. The fuel cell power system according to claim 68 wherein the at least one fuel cell comprises a plurality of polymer electrolyte membrane fuel cells.

71. The fuel cell power system according to claim 68 wherein the at least one fuel cell comprises a plurality of fuel cells.

1 72. The fuel cell power system according to claim 71 wherein
2 the fuel cells are configured to be individually selectively deactivated
3 and remaining ones of the fuel cells are configured to provide electricity
4 to the terminals with others of the fuel cells deactivated.

5
6 73. The fuel cell power system according to claim 68¹⁶⁰ further
7 comprising an operator interface and the control system is configured
8 to control the operator interface to indicate the at least one electrical
9 condition.

10
11 74. The fuel cell power system according to claim 68 further
12 comprising a fan configured to direct air to the at least one fuel cell
13 and the control system is configured to control the fan responsive to
14 the at least one electrical condition.

15
16 75. A fuel cell power system comprising:
17 a plurality of terminals;
18 a plurality of fuel cells electrically coupled with the terminals and
19 configured to convert chemical energy into electricity;
20 a main valve adapted to couple with a fuel source and configured
21 to selectively supply fuel to the fuel cells; and
22 a control system configured to control the main valve.

1 76. The fuel cell power system according to claim 75 wherein
2 the control system comprises a plurality of distributed controllers.

3
4 77. The fuel cell power system according to claim 75 wherein
5 the fuel cells comprise polymer electrolyte membrane fuel cells.

6
7 78. The fuel cell power system according to claim 75 wherein
8 the fuel cells are configured to be individually selectively deactivated
9 and remaining ones of the fuel cells are configured to provide electricity
10 to the terminals with others of the fuel cells deactivated.

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12 ~~79. The fuel cell power system according to claim 75 further~~
13 ~~comprising a plurality of auxiliary valves configured to selectively supply~~
14 ~~fuel to respective fuel cells.~~
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80. A fuel cell power system comprising:

2 a housing;

3 a plurality of terminals;

4 at least one fuel cell within the housing and electrically coupled
5 with the terminals and configured to convert chemical energy into
6 electricity;

7 an air temperature control assembly configured to direct air within
8 the housing to the at least one fuel cell and comprising a modifying
9 element configured to condition the temperature of the air; and

10 a control system configured to control the modifying element.

11 71
12 81. The fuel cell power system according to claim 80 wherein
13 the control system comprises a plurality of distributed controllers.

14 72
15 82. The fuel cell power system according to claim 80 wherein
16 the at least one fuel cell comprises a plurality of polymer electrolyte
17 membrane fuel cells.

18 73
19 83. The fuel cell power system according to claim 80 wherein
20 the at least one fuel cell comprises a plurality of fuel cells.

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84. The fuel cell power system according to claim 83 wherein the fuel cells are configured to be individually selectively deactivated and remaining ones of the fuel cells are configured to provide electricity to the terminals with others of the fuel cells deactivated.

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85. The fuel cell power system according to claim 80 further comprising a temperature sensor configured to monitor the temperature of the directed air within the housing.

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86. The fuel cell power system according to claim 85 wherein the control system is configured to monitor the temperature of the directed air from the temperature sensor and to control the modifying element responsive to the monitoring of the temperature.

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87. The fuel cell power system according to claim 80 wherein the modifying element comprises a heater.

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88. A fuel cell power system comprising:

a housing;

a plurality of terminals;

at least one fuel cell within the housing and electrically coupled with the terminals and configured to convert chemical energy into electricity;

a fuel delivery system configured to supply fuel to the at least one fuel cell;

a fuel sensor positioned within the housing; and

a control system configured to monitor a detection of fuel within the housing using the fuel detection sensor.

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89. The fuel cell power system according to claim 88 wherein the control system comprises a plurality of distributed controllers.

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90. The fuel cell power system according to claim 88 wherein the at least one fuel cell comprises a plurality of polymer electrolyte membrane fuel cells.

81
91. The fuel cell power system according to claim 88 wherein the at least one fuel cell comprises a plurality of fuel cells.

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92. The fuel cell power system according to claim 91 wherein
the fuel cells are configured to be individually selectively deactivated
and remaining ones of the fuel cells are configured to provide electricity
to the terminals with others of the fuel cells deactivated.

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93. The fuel cell power system according to claim 88 further
comprising an operator interface and the control system is configured
to control the operator interface to indicate a detection of fuel.

94. The fuel cell power system according to claim 88 wherein
the fuel sensor comprises a hydrogen gas sensor.

95. The fuel cell power system according to claim 88 wherein
the at least one fuel cell comprises a plurality of fuel cells, and the
fuel delivery system comprises a plurality of valves configured supply
fuel to respective ones of the fuel cells.

96. The fuel cell power system according to claim 95 wherein
the control system is configured to selectively close the valves responsive
to a detection of fuel using the fuel sensor.

97. The fuel cell power system according to claim 88 further
comprising a heater configured to selectively impart heat flux to the
fuel sensor.

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98. A fuel cell power system comprising:

a housing;

a plurality of terminals;

at least one fuel cell within the housing and electrically coupled with the terminals and configured to convert chemical energy into electricity;

a temperature sensor within the housing; and

a control system coupled with the temperature sensor and configured to monitor the temperature in the housing using the temperature sensor.

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99. The fuel cell power system according to claim 98 wherein the control system comprises a plurality of distributed controllers.

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100. The fuel cell power system according to claim 98 wherein the at least one fuel cell comprises a plurality of polymer electrolyte membrane fuel cells.

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101. The fuel cell power system according to claim 98 wherein the at least one fuel cell comprises a plurality of fuel cells.

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102. The fuel cell power system according to claim 101 wherein the fuel cells are configured to be individually selectively deactivated and remaining ones of the fuel cells are configured to provide electricity to the terminals with others of the fuel cells deactivated.

103. The fuel cell power system according to claim 98 further comprising an air temperature control assembly configured to at least one of increase and decrease the temperature in the housing.

104. The fuel cell power system according to claim 103 wherein the control system is configured to control the air temperature control assembly.

105. The fuel cell power system according to claim 103 wherein the control system is configured to control the air temperature control assembly to maintain the temperature in the housing within a predefined range.

106. The fuel cell power system according to claim 103 wherein the control system is configured to control the air temperature control assembly to maintain the temperature in the housing within a predefined range of approximately 25 °Celsius to 80 °Celsius.

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107. The fuel cell power system according to claim 103 wherein
the air temperature control assembly comprises:

a fan configured to circulate air within the housing; and
an air flow device configured to permit selective passage of air
at least one of into and out of the housing.

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108. The fuel cell power system according to claim 107 wherein
the control system is configured to control the fan and the air flow
device.

99
109. The fuel cell power system according to claim 98 further
comprising a temperature sensor configured to monitor a temperature
exterior of the housing.

100
110. A fuel cell power system comprising:
a plurality of terminals;
at least one fuel cell within the housing and electrically coupled
with the terminals and configured to convert chemical energy into
electricity;
at least one switching device configured to selectively shunt the
at least one fuel cell; and
a control system configured to control the at least one switching
device.

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111. The fuel cell power system according to claim 110 wherein the control system comprises a plurality of distributed controllers.

112. The fuel cell power system according to claim 110 wherein the at least one fuel cell comprises a plurality of polymer electrolyte membrane fuel cells.

113. The fuel cell power system according to claim 110 wherein the at least one fuel cell comprises a plurality of fuel cells.

114. The fuel cell power system according to claim 113 wherein the fuel cells are configured to be individually selectively deactivated and remaining ones of the fuel cells are configured to provide electricity to the terminals with others of the fuel cells deactivated.

115. The fuel cell power system according to claim 110 wherein the control system is configured to shunt the at least one fuel cell for a variable period of time.

116. The fuel cell power system according to claim 110 wherein the at least one fuel cell comprises plural fuel cells and the at least one switching device comprises plural switching devices.

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117. The fuel cell power system according to claim 116 wherein the control system is configured to sequentially shunt the fuel cells using the respective switching devices.

118. The fuel cell power system according to claim 116 wherein the control system is configured to shunt individual ones of the fuel cells using the respective switching devices.

119. The fuel cell power system according to claim 116 wherein the control system is configured to shunt the individual ones of the fuel cells according to a specified order.

120. The fuel cell power system according to claim 116 further comprising a plurality of valves individually configured to selectively supply fuel to respective fuel cells, and wherein the control system is configured to control the valves.

121. The fuel cell power system according to claim 120 wherein the control system is configured to cease supply of fuel to shunted fuel cells using respective ones of the valves.

122. The fuel cell power system according to claim 116 wherein the switching devices comprise MOSFET switching devices.

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123. A fuel cell power system comprising:

a housing;

a plurality of terminals;

at least one fuel cell within the housing and electrically coupled with the terminals and configured to convert chemical energy into electricity;

a switching device coupled intermediate the at least one fuel cell and one of the terminals; and

a control system coupled with the switching device and configured to control the switching device to selectively couple the terminal with the at least one fuel cell.

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124. The fuel cell power system according to claim 123 wherein the control system comprises a plurality of distributed controllers.

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125. The fuel cell power system according to claim 123 wherein the at least one fuel cell comprises a plurality of polymer electrolyte membrane fuel cells.

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126. The fuel cell power system according to claim 123 wherein the at least one fuel cell comprises a plurality of fuel cells.

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1 127. The fuel cell power system according to claim 126 wherein
2 the fuel cells are configured to be individually selectively deactivated
3 and remaining ones of the fuel cells are configured to provide electricity
4 to the terminals with others of the fuel cells deactivated.

5
6 128. The fuel cell power system according to claim 123 wherein
7 the switching device comprises at least one MOSFET switching device.

8
9 129. The fuel cell power system according to claim 123 further
10 comprising a temperature sensor positioned within the housing, and the
11 control system is configured to monitor the temperature within the
12 housing and to couple the terminal with the at least one fuel cell using
13 the switching device responsive to the temperature being within a
14 predefined range.

15
16 130. A method of controlling a fuel cell power system comprising:
17 providing a plurality of fuel cells individually configured to convert
18 chemical energy into electricity;
19 electrically coupling the plurality of fuel cells;
20 providing a first terminal coupled with the fuel cells;
21 providing a second terminal coupled with the fuel cells; and
22 coupling a digital control system with the fuel cells to at least
23 one of monitor and control an operation of the fuel cells.
24

1120
131. The method according to claim 130 further comprising
monitoring the operation of the fuel cells.

1121
132. The method according to claim 130 further comprising
controlling the operation of the fuel cells.

1122
133. The method according to claim 130 wherein the coupling the
control system comprises coupling a plurality of distributed controllers.

1123
134. The method according to claim 130 wherein the providing
the fuel cells comprises providing polymer electrolyte membrane fuel
cells.

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135. The method according to claim 134 further comprising
deactivating at least one of the fuel cells.

136. The method according to claim 135 wherein the deactivating
comprises physically removing.

137. The method according to claim 135 wherein the deactivating
comprises electrically bypassing.

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138. The method according to claim 135 further comprising providing electricity to a load coupled with the terminals with the at least one fuel cell deactivated.

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139. The method according to claim 130 further comprising selectively shunting at least one of the fuel cells.

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140. The method according to claim 130 further comprising:
monitoring at least one electrical characteristic of the fuel cells;
and
shunting at least one of the fuel cells responsive to the monitoring.

130
141. The method according to claim 130 further comprising maintaining an air temperature about the fuel cells in a predefined range.

131
142. The method according to claim 130 further comprising maintaining an air temperature about the fuel cells in a predefined range of approximately 25 °Celsius to 80 °Celsius.

132
143. The method according to claim 130 further comprising directing air to the fuel cells using a fan.

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144. The method according to claim 143 further comprising:

2 monitoring a load coupled with the terminals; and

3 controlling the fan responsive to the monitoring using the control
4 system.

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145. The method according to claim 130 further comprising:

7 supplying fuel to the fuel cells using a plurality of auxiliary
8 valves; and

9 controlling the auxiliary valves using the control system.

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146. The method according to claim 145 further comprising:

12 supplying fuel to the auxiliary valves using a main valve; and
13 controlling the main valve using the control system. How early?

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147. The method according to claim 130 further comprising:

16 communicating with a remote device using a communication port;

17 and

18 controlling the communicating using the control system.

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148. The method according to claim 130 further comprising:

21 switching a connection intermediate one of the terminals and the
22 fuel cells; and

23 controlling the switching using the control system.

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149. The method according to claim 130 further comprising:

monitoring for the presence of fuel within a housing about the
fuel cells; and

implementing a shut down operation responsive to the monitoring
using the control system.

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150. The method according to claim 149 wherein the
implementing deactivates one or more of the fuel cells.

151. The method according to claim 149 wherein the
implementing deactivates all of the fuel cells.

152. A method of controlling a fuel cell power system comprising:
providing at least one fuel cell configured to convert chemical
energy into electricity;

providing a first terminal coupled with the at least one fuel cell;
providing a second terminal coupled with the at least one fuel
cell;

supplying fuel to the at least one fuel cell; and
controlling the supplying using a control system.

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153. The method according to claim 152 wherein the controlling
comprises controlling using the control system comprising a plurality of
distributed controllers.

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154. The method according to claim 152 wherein the providing the at least one fuel cell comprises providing the at least one fuel cell having a plurality of polymer electrolyte membrane fuel cells.

155. The method according to claim 152 wherein the providing the at least one fuel cell comprises providing a plurality of fuel cells.

156. The method according to claim 155 further comprising deactivating at least one of the fuel cells.

157. The method according to claim 156 further comprising providing electricity to a load coupled with the terminals with the at least one fuel cell deactivated.

158. The method according to claim 152 further comprising monitoring at least one electrical characteristic of the at least one fuel cell, and the controlling is responsive to the monitoring.

159. A method of controlling a fuel cell power system comprising:
providing at least one fuel cell configured to convert chemical
energy into electricity;
providing a first terminal coupled with the at least one fuel cell;
providing a second terminal coupled with the at least one fuel
cell;
selectively exhausting a connection coupled with the at least one
fuel cell; and
controlling the exhausting using a control system.

160. The method according to claim 159 wherein the controlling
comprises controlling using the control system comprising a plurality of
distributed controllers.

161. The method according to claim 159 wherein the providing
the at least one fuel cell comprises providing the at least one fuel cell
having a plurality of polymer electrolyte membrane fuel cells.

162. The method according to claim 159 wherein the providing
the at least one fuel cell comprises providing a plurality of fuel cells.

163. The method according to claim 162 further comprising
deactivating at least one of the fuel cells.

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164. The method according to claim 163 further comprising providing electricity to a load coupled with the terminals with the at least one fuel cell deactivated.

165. The method according to claim 159 wherein the selectively exhausting comprises periodically exhausting responsive to control of the control system.

166. The method according to claim 159 wherein the exhausting comprises exhausting using a bleed valve.

167. The method according to claim 159 wherein the exhausting comprises exhausting from an anode of the at least one fuel cell.

168. A method of controlling a fuel cell power system comprising:
providing at least one fuel cell configured to convert chemical energy into electricity;
providing a first terminal coupled with the at least one fuel cell;
providing a second terminal coupled with the at least one fuel cell;
directing air to the at least one fuel cell; and
controlling the directing using a control system.

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169. The method according to claim 168 wherein the controlling comprises controlling using the control system comprising a plurality of distributed controllers.

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170. The method according to claim 168 wherein the providing the at least one fuel cell comprises providing the at least one fuel cell having a plurality of polymer electrolyte membrane fuel cells.

158
171. The method according to claim 168 wherein the providing the at least one fuel cell comprises providing a plurality of fuel cells.

159
172. The method according to claim 171 further comprising deactivating at least one of the fuel cells.

160
173. The method according to claim 172 further comprising providing electricity to a load coupled with the terminals with the at least one fuel cell deactivated.

154
174. The method according to claim 168 further comprising providing electricity to a load coupled with the terminals, and the controlling is responsive to the monitoring.

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175. The method according to claim 168 further comprising monitoring at least one of voltage of the at least one fuel cell and current passing through the at least one fuel cell, and the controlling is responsive to the monitoring.

1163 1155
176. The method according to claim 168 wherein the directing comprises directing air into a cathode side of the at least one fuel cell.

1164 1163
177. The method according to claim 176 wherein the directing comprises directing using a fan, and the controlling comprises controlling an air flow rate of the fan.

1165 1155
178. The method according to claim 168 further comprising introducing exterior air into a housing about the at least one fuel cell.

Sub 1158
179. The method according to claim 168 further comprising monitoring the temperature of the air.

180. The method according to claim 179 further comprising controlling a modifying element using the control system to control the temperature of the air responsive to the monitoring.

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1 181. A method of controlling a fuel cell power system comprising:
2 providing at least one fuel cell configured to convert chemical
3 energy into electricity;
4 providing a first terminal coupled with the at least one fuel cell;
5 providing a second terminal coupled with the at least one fuel
6 cell;
7 indicating at least one operational status of the fuel cell power
8 system using an operator interface; and
9 controlling the indicating using a control system.

10
11 1169 1168
12 182. The method according to claim 181 wherein the controlling
13 comprises controlling using the control system comprising a plurality of
14 distributed controllers.

15 1170 1168
16 183. The method according to claim 181 wherein the providing
17 the at least one fuel cell comprises providing the at least one fuel cell
18 having a plurality of polymer electrolyte membrane fuel cells.

19 1171 1168
20 184. The method according to claim 181 wherein the providing
21 the at least one fuel cell comprises providing a plurality of fuel cells.

22 1172 1171
23 185. The method according to claim 184 further comprising
24 deactivating at least one of the fuel cells.

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1173
186. The method according to claim 185 further comprising
providing electricity to a load coupled with the terminals with the at
least one fuel cell deactivated.

1174
187. The method according to claim 181 wherein the indicating
comprises emitting a human perceptible signal.

1175
188. The method according to claim 181 wherein the indicating
comprises indicating using a display.

1176
189. The method according to claim 181 further comprising
forwarding the at least one operational status to a remote device.

1177
190. The method according to claim 181 further comprising
receiving operator inputs using the operator interface.

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1 191. A method of controlling a fuel cell power system comprising:
2 providing at least one fuel cell configured to convert chemical
3 energy into electricity;
4 providing a first terminal coupled with the at least one fuel cell;
5 providing a second terminal coupled with the at least one fuel
6 cell;
7 supplying electricity using a power supply; and
8 monitoring at least one electrical condition of the power supply
9 using a control system.

(To WMT)

10 192. The method according to claim 191 wherein the controlling
11 comprises controlling using the control system comprising a plurality of
12 distributed controllers.

13 193. The method according to claim 191 wherein the providing
14 the at least one fuel cell comprises providing the fuel cell having a
15 plurality of polymer electrolyte membrane fuel cells.

16 194. The method according to claim 191 wherein the providing
17 the at least one fuel cell comprises providing a plurality of fuel cells.

18 195. The method according to claim 194 further comprising
19 deactivating at least one of the fuel cells.
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181 182

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178

196. The method according to claim 195 further comprising providing electricity to a load coupled with the terminals with the at least one fuel cell deactivated.

197. The method according to claim 191 wherein the supplying comprises supplying electricity to the control system.

198. The method according to claim 191 wherein the supplying comprises supplying power using the power supply comprising a battery.

199. The method according to claim 198 further comprising:
charging the battery; and
controlling the charging using the control system.

200. A method of controlling a fuel cell power system comprising:
providing at least one fuel cell configured to convert chemical energy into electricity;
providing a first terminal coupled with the at least one fuel cell;
providing a second terminal coupled with the at least one fuel cell; and
monitoring an electrical condition of the at least one fuel cell using a control system.

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186
201. The method according to claim 200 wherein the controlling comprises controlling using the control system comprising a plurality of distributed controllers.

187
202. The method according to claim 200 wherein the providing the at least one fuel cell comprises providing the fuel cell having a plurality of polymer electrolyte membrane fuel cells.

188
203. The method according to claim 200 wherein the providing the at least one fuel cell comprises providing a plurality of fuel cells.

189
204. The method according to claim 203 further comprising deactivating at least one of the fuel cells.

190
205. The method according to claim 204 further comprising providing electricity to a load coupled with the terminals with the at least one fuel cell deactivated.

191
206. The method according to claim 200 further comprising indicating the electrical condition using an operator interface.

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1192 185.185
207. The method according to claim 200 further comprising:

directing air to the at least one fuel cell; and

controlling the directing using the control system responsive to the monitoring.

SP 1193

208. The method according to claim 200 further comprising shunting the at least one fuel cell after the monitoring.

209. A method of controlling a fuel cell power system comprising: providing a plurality of fuel cells individually configured to convert chemical energy into electricity;

providing a first terminal coupled with the fuel cells;

providing a second terminal coupled with the fuel cells;

supplying fuel to the fuel cells; and

controlling the supplying using a control system.

1195 1194
210. The method according to claim 209 wherein the controlling comprises controlling using the control system comprising a plurality of distributed controllers.

1196 1194
211. The method according to claim 209 wherein the providing the fuel cells comprises providing a plurality of polymer electrolyte membrane fuel cells.

92

1 212. The method according to claim 209 further comprising
2 deactivating at least one of the fuel cells.

3
4 213. The method according to claim 212 further comprising
5 providing electricity to a load coupled with the terminals with the at
6 least one fuel cell deactivated.

7
8 214. The method according to claim 209 wherein the supplying
9 comprises supplying using a main valve.

10
11 215. The method according to claim 209 wherein the supplying
12 comprises:

13 supplying using a main valve; and

14 supplying using a plurality of auxiliary valves.

15
16 216. The method according to claim 215 wherein the controlling
17 comprises controlling the main valve and the auxiliary valves using the
18 control system.

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1 217. A method of controlling a fuel cell power system comprising:
2 providing at least one fuel cell configured to convert chemical
3 energy into electricity;
4 providing a first terminal coupled with the at least one fuel cell;
5 providing a second terminal coupled with the at least one fuel
6 cell;
7 supplying fuel to the at least one fuel cell; and
8 monitoring for the presence of fuel within a housing about the
9 at least one fuel cell using a control system.

10 218. The method according to claim 217 wherein the controlling
11 comprises controlling using the control system comprising a plurality of
12 distributed controllers.

13 219. The method according to claim 217 wherein the providing
14 the at least one fuel cell comprises providing the fuel cell having a
15 plurality of polymer electrolyte membrane fuel cells.

16 220. The method according to claim 217 wherein the providing
17 the at least one fuel cell comprises providing a plurality of fuel cells.

18 221. The method according to claim 220 further comprising
19 deactivating at least one of the fuel cells.

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207
222. The method according to claim 221 further comprising
providing electricity to a load coupled with the terminals with the at
least one fuel cell deactivated.

208
202
223. The method according to claim 217 further comprising:
coupling an operator interface with the control system; and
controlling the operator interface using the control system to
indicate the presence of fuel within the housing.

209
202
224. The method according to claim 217 further comprising:
selectively ceasing the supplying responsive to the monitoring; and
controlling the ceasing using the control system.

210
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225. The method according to claim 217 wherein the monitoring
comprises monitoring using a fuel sensor.

211
209
226. The method according to claim 225 further comprising
heating the fuel sensor.

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1 227. A method of controlling a fuel cell power system comprising:
2 providing at least one fuel cell configured to convert chemical
3 energy into electricity;
4 providing a first terminal coupled with the at least one fuel cell;
5 providing a second terminal coupled with the at least one fuel
6 cell; and
7 monitoring a temperature within a housing about the at least one
8 fuel cell using a control system.

213 212
10 228. The method according to claim 227 wherein the controlling
11 comprises controlling using the control system comprising a plurality of
12 distributed controllers.

214 212
14 229. The method according to claim 227 wherein the providing
15 the at least one fuel cell comprises providing the fuel cell having a
16 plurality of polymer electrolyte membrane fuel cells.

215 212
18 230. The method according to claim 227 wherein the providing
19 the at least one fuel cell comprises providing a plurality of fuel cells.

216 215
21 231. The method according to claim 230 further comprising
22 deactivating at least one of the fuel cells.

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217
232. The method according to claim 231 further comprising
providing electricity to a load coupled with the terminals with the at
least one fuel cell deactivated.

218 212
233. The method according to claim 227 further comprising
selectively one of increasing and decreasing the temperature in the
housing using an air temperature control assembly.

219 218
234. The method according to claim 233 further comprising
controlling the air temperature control assembly using the control system
and responsive to the monitoring.

220 219
235. The method according to claim 234 wherein the controlling
comprises controlling to maintain the temperature in the housing within
a predefined range.

221 219
236. The method according to claim 234 wherein the controlling
comprises controlling to maintain the temperature in the housing within
a predefined range of approximately 25 °Celsius and 80 °Celsius.

222 -212
237. The method according to claim 227 further comprising:
directing air to the at least one fuel cell; and
controlling the directing using the control system and responsive
to the monitoring.

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223
238. The method according to claim 227 further comprising:

inputting exterior air into the housing; and

controlling the inputting using the control system and responsive to the monitoring.

224
239. The method according to claim 227 further comprising monitoring a temperature exterior of the housing.

225
240. The method according to claim 227 wherein the monitoring comprises monitoring using a temperature sensor.

241. A method of controlling a fuel cell power system comprising:
providing at least one fuel cell configured to convert chemical energy into electricity;
providing a first terminal coupled with the at least one fuel cell;
providing a second terminal coupled with the at least one fuel cell;
shunting the at least one fuel cell; and
controlling the shunting using a control system.

226
242. The method according to claim 241 wherein the controlling comprises controlling using the control system comprising a plurality of distributed controllers.

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1 243. The method according to claim 241 wherein the providing
2 the at least one fuel cell comprises providing the fuel cell having a
3 plurality of polymer electrolyte membrane fuel cells.

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4
5 244. The method according to claim 241 further comprising
6 varying a period of time of the shunting using the control system.

245. The method according to claim 241 wherein the providing
8 the at least one fuel cell comprises providing a plurality of fuel cells.

246 The method according to claim 245 further comprising
12 deactivating at least one of the fuel cells.

1231 1230

13
14 247. The method according to claim 246 further comprising
15 providing electricity to a load coupled with the terminals with the at
16 least one fuel cell deactivated.

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18 248. The method according to claim 245 further comprising
19 sequentially shunting the fuel cells.

20
21 249. The method according to claim 245 further comprising
22 shunting individual ones of the fuel cells.

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250. The method according to claim 245 further comprising shunting the fuel cells according to a specified order.

251. The method according to claim 245 further comprising:
supplying fuel to the fuel cells; and
ceasing the supplying to shunted fuel cells.

252. A method of controlling a fuel cell power system comprising:
providing at least one fuel cell configured to convert chemical energy into electricity;
providing a first terminal coupled with the at least one fuel cell;
providing a second terminal coupled with the at least one fuel cell;
switching a connection immediate one of the terminals and the at least one fuel cell; and
controlling the switching using a control system.

253. The method according to claim 252 wherein the controlling comprises controlling using the control system comprising a plurality of distributed controllers.

254. The method according to claim 252 wherein the providing the at least one fuel cell comprises providing the fuel cell having a plurality of polymer electrolyte membrane fuel cells.

239.
255. The method according to claim 232 wherein the providing
the at least one fuel cell comprises providing a plurality of fuel cells.

240
239
256. The method according to claim 255 further comprising
deactivating at least one of the fuel cells.

241
240
257. The method according to claim 256 further comprising
providing electricity to a load coupled with the terminals with the at
least one fuel cell deactivated.

258. The method according to claim 252 further comprising
monitoring a temperature within a housing about the at least one fuel
cell and the controlling is responsive to the monitoring.

243
259. A method of operating a fuel cell power system comprising:
initiating a start-up procedure;
monitoring the temperature within a housing containing at least
one fuel cell;
selectively adjusting the temperature within the housing using a
modifying element responsive to the monitoring; and
coupling a power bus with a terminal responsive to the
monitoring.

244
260. The method according to claim 259 further comprising
monitoring for the presence of fuel.

245
261. The method according to claim 259 further comprising:
shunting the at least one fuel cell according to a duty cycle; and
selectively setting the duty cycle to maximum.

246
262. The method according to claim 259 wherein the adjusting
comprises heating using the modifying element to increase the
temperature.

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